# L.A. AFB V2G PILOT PROJECT

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# Outline

PROJECT OVERVIEW & RELEVANCY

CAISO ANCILLARY SERVICES PROCUREMENT

SOFTWARE DEVELOPMENT

INSTALLATION AT LOS ANGELES AIR FORCE BASE

EXAMPLE FLEET RESULTS

BIDIRECTIONAL PLUG-IN ELECTRIC VEHICLE TECHNOLOGY

PROJECT CHALLENGES

# Project Overview

- 6 DoD bases with 500 PEVs announced, including China Lake CA
  - third phase will be 1000 additional vehicles of total non-tactical fleet of ~200,000
    - (mostly low usage medium duty vehicles)
- about half L.A. AFB fleet will bid into CAISO Regulation (Aug 2013)
- Three L.A. funding sources:
  - DOD ~2+ M$ for vehicles, charging stations, and construction
  - ESTCP ~1.75 M$ for fleet management, communications, & optimization
  - CEC ~1 M$ for 10-15 sedans and building integration capability
- first vehicles + EVSEs by Aug 2013
- hoping for a full year of data collection through mid-2014
- key research questions:
  - can an all-electric fleet meet mission requirements
  - can regulation market revenue close PEV cost gap

# Why Relevant?

- between PEV-microgrid interaction a likely key component
- PEV batteries valuable storage
- PEV charging-discharging controllable and fast responding
- vehicle to grid (V2G) a precursor
  to microgrid to megagrid (m-μ2MG)
- controlled microgrids will be participants in ISO markets
- function at scales consistent with current grid practice

# CAISO Ancillary Services

## Regulation

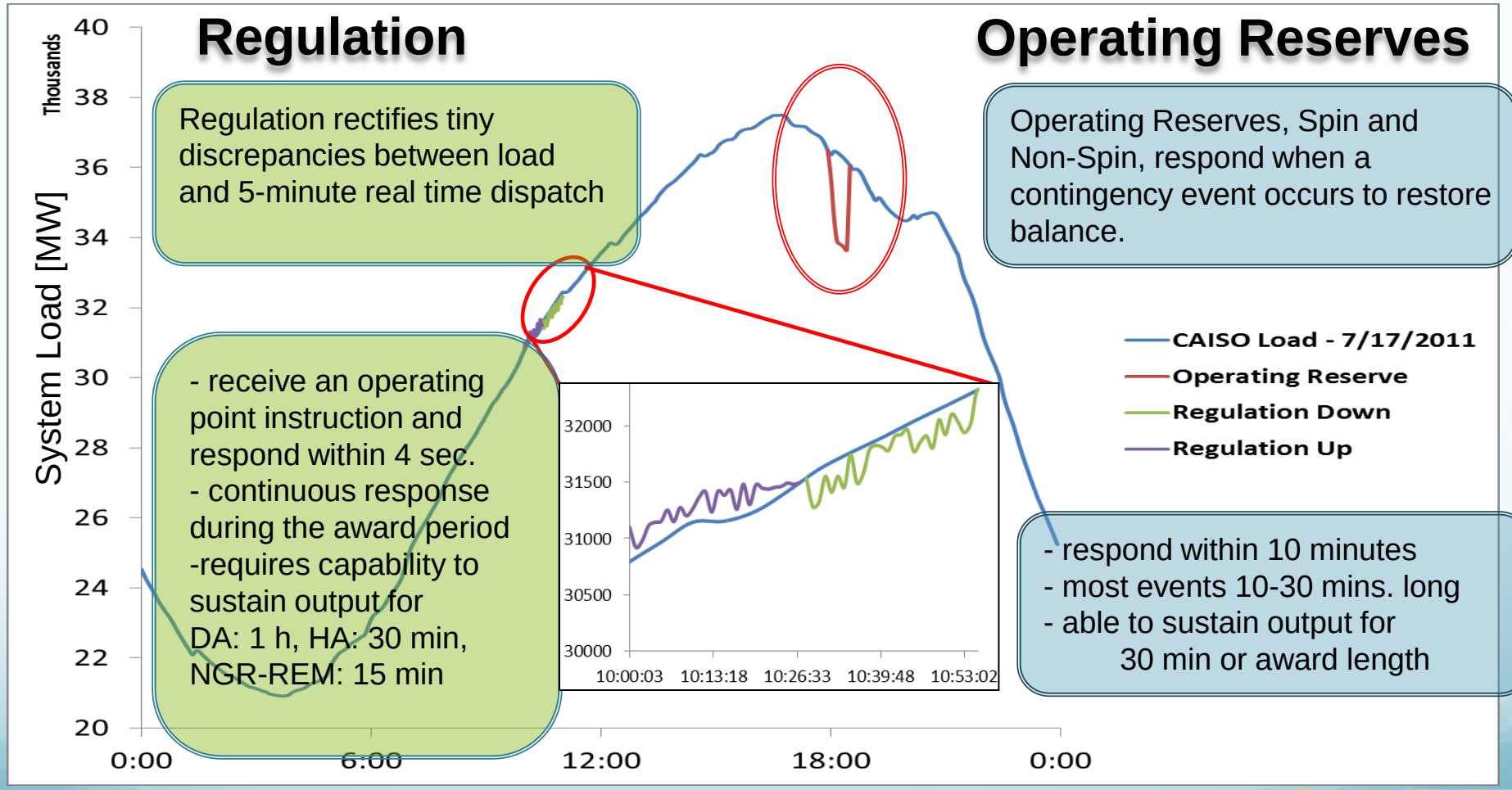
Regulation rectifies tiny discrepancies between load and 5-minute real time dispatch

- receive an operating point instruction and respond within 4 sec.
- continuous response during the award period
-requires capability to sustain output for
DA: 1 h, HA: 30 min,
NGR-REM: 15 min

## Operating Reserves

Operating Reserves, Spin and Non-Spin, respond when a contingency event occurs to restore balance.

- respond within 10 minutes
- most events 10-30 mins. long
- able to sustain output for
30 min or award length



# CAISO RegU+D Prices

## (Apr 2009 – Mar 2012)

| | Avg [$/MW-h] | Std Dev [$/MW-h] | Min [$/MW-h] | Max [$/MW-h] |
|---|---|---|---|---|
| **Regulation Up** | 9.13 | 9.63 | 0.00 | 545.27 |
| **Regulation Down** | 6.91 | 5.63 | 0.00 | 79.55 |
| **Spinning Reserve** | 6.61 | 8.02 | 0.00 | 440.92 |
| **Non-Spinning reserve** | 0.97 | 4.34 | 0.00 | 416.33 |

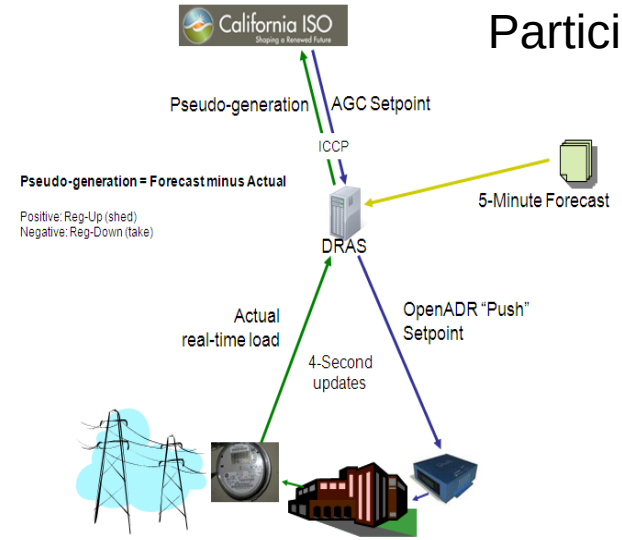
- A symmetric combined regulation award has an average value of $16.04/MW-h.
- On average Regulation is about 2.5 times more valuable than Spinning Reserve, and approximately 16 times more valuable than Non-Spinning Reserve.
- MW-h is the unit used for ancillary awards. It is defined as one MW of power capacity held in reserve for one hour (it is not a unit of energy)
- 10-15 k-vehicles could provide all of SoCal's regulation requirement

Source: Ventyx Velocity Suite

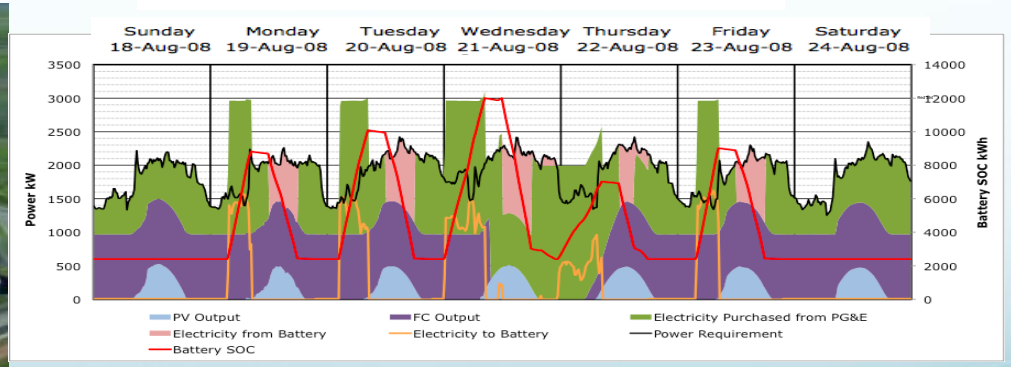
# 3 Required Technologies

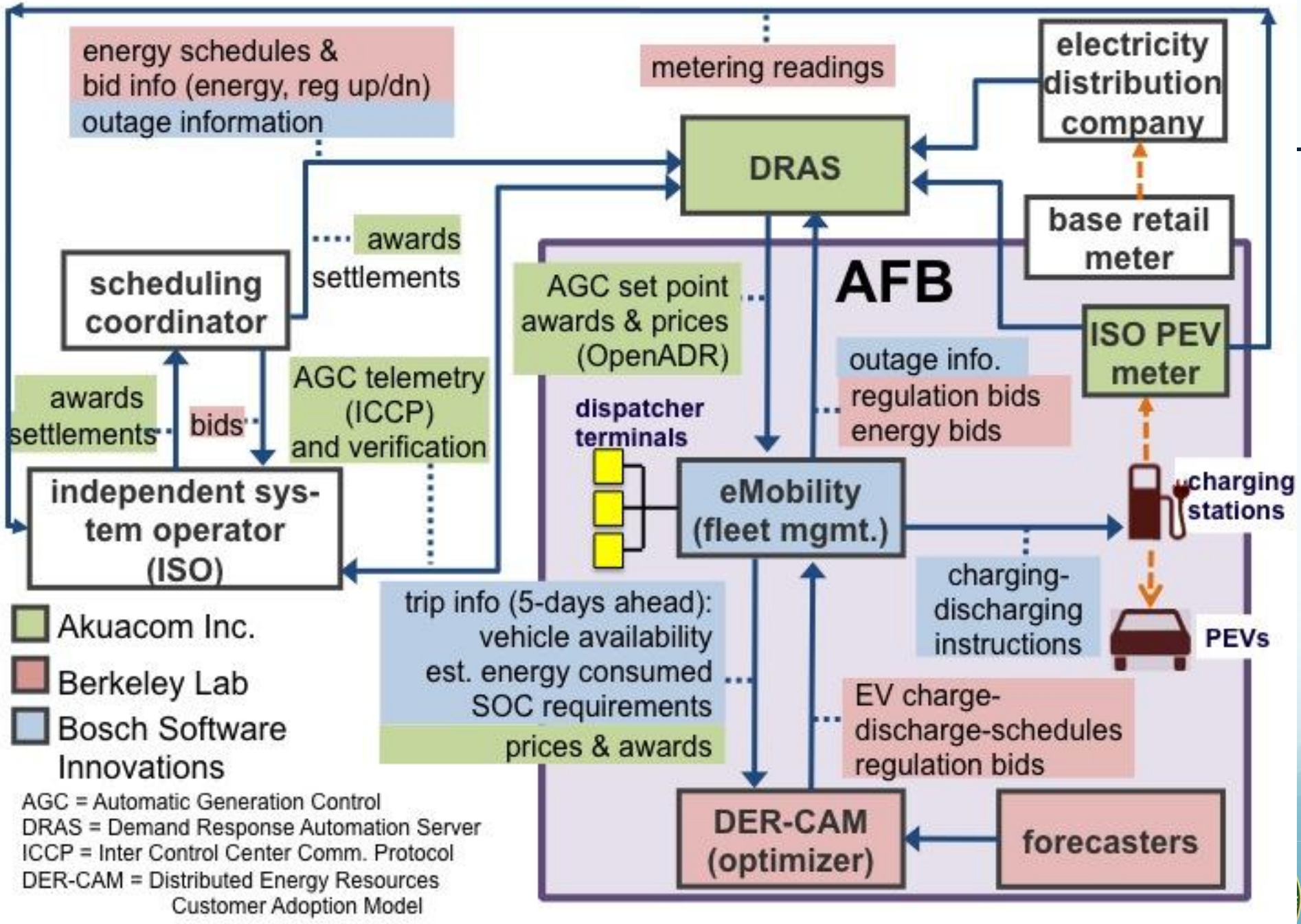
Singapore

Santa Rita Jail



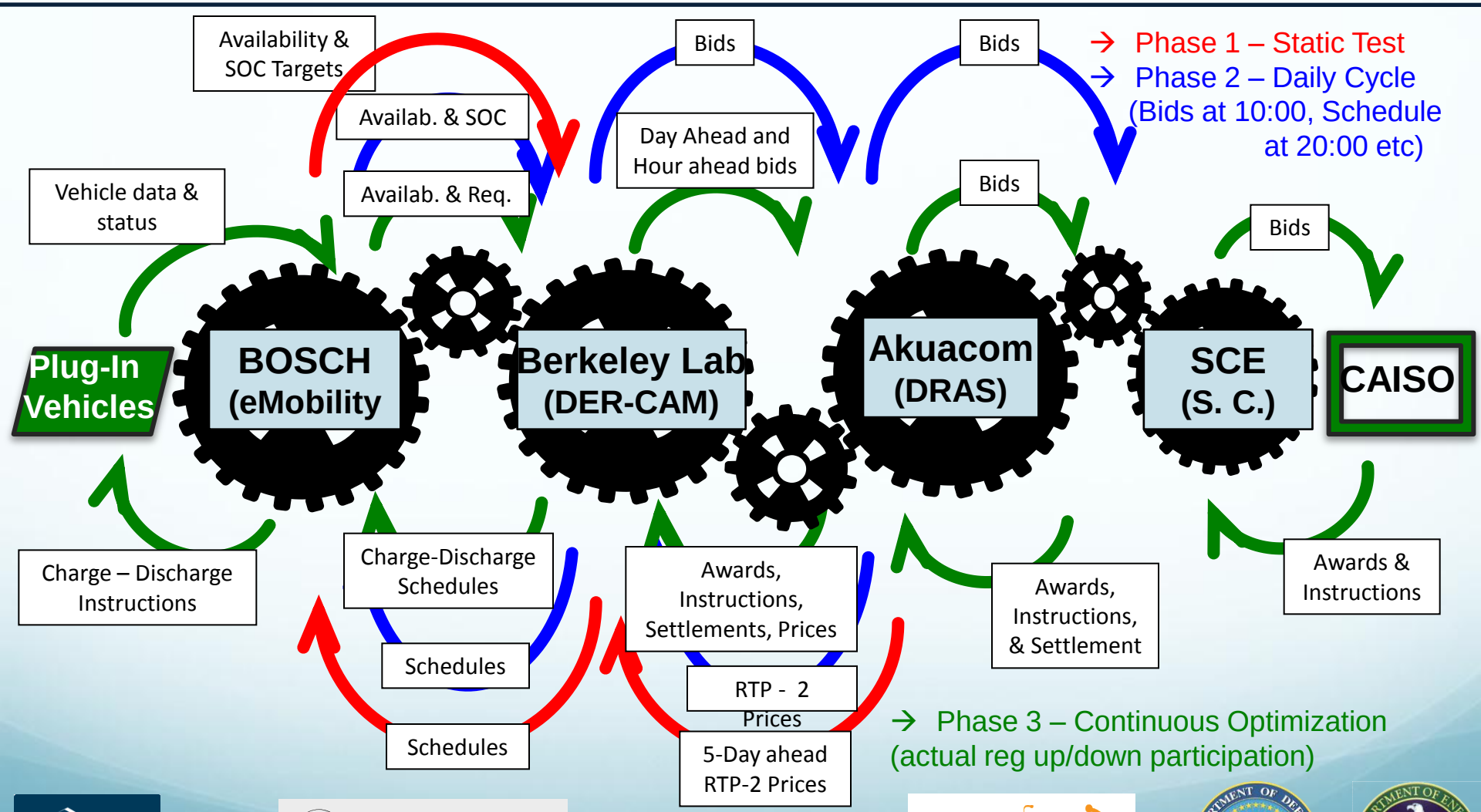

Participating Load Pilot




Jason MacDonald, Nicholas DeForest, and Judy Lai, Berkeley Lab 6 May2013

# Data Machinery

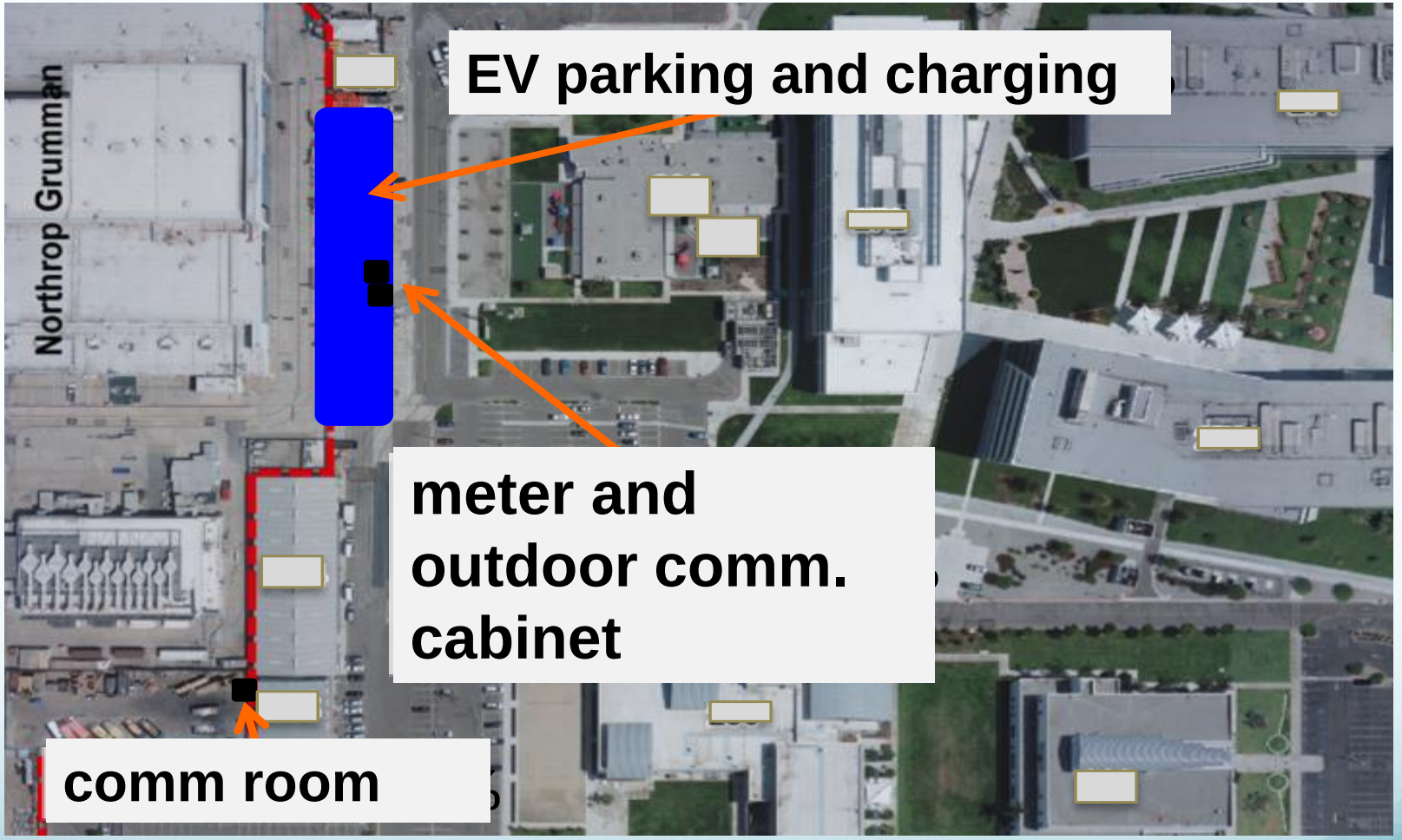



→ Phase 1 – Static Test
→ Phase 2 – Daily Cycle (Bids at 10:00, Schedule at 20:00 etc)

→ Phase 3 – Continuous Optimization (actual reg up/down participation)

BOSCH
Invented for life

# Aerial View of L.A. AFB



# L.A. AFB Views

# 18 Vehicle Test Fleet

| | EV1-EV6 | EV7-EV12 | EV13-EV18 |
|---|---|---|---|
| |  |  |  |
| Model | **Nissan LEAF** | **Auto Port Van** | **Smith Electric Truck** |
| Number | 6 | 6 | 6 |
| Energy Capacity | 24 kWh | 35 kWh | 120 kWh |
| Max Charge Power | 15 kW | 15 kW | 60 kW |
| Max Discharge Power | 15 kW | 15 kW | 60 kW |

| | |
|---|---|
| Total Energy Capacity | 1074 kWh |
| Total Charge Power | 540 kW |
| Total Discharge Power | 540 kW |

| | |
|---|---|
| Minimum Resource Size | 500 kW |
| Minimum Bid | 100 kW |
| Minimum Bid Increment | 10 kW |

# Bidirectional Power

1. Nissan LEAF using CHAdeMO

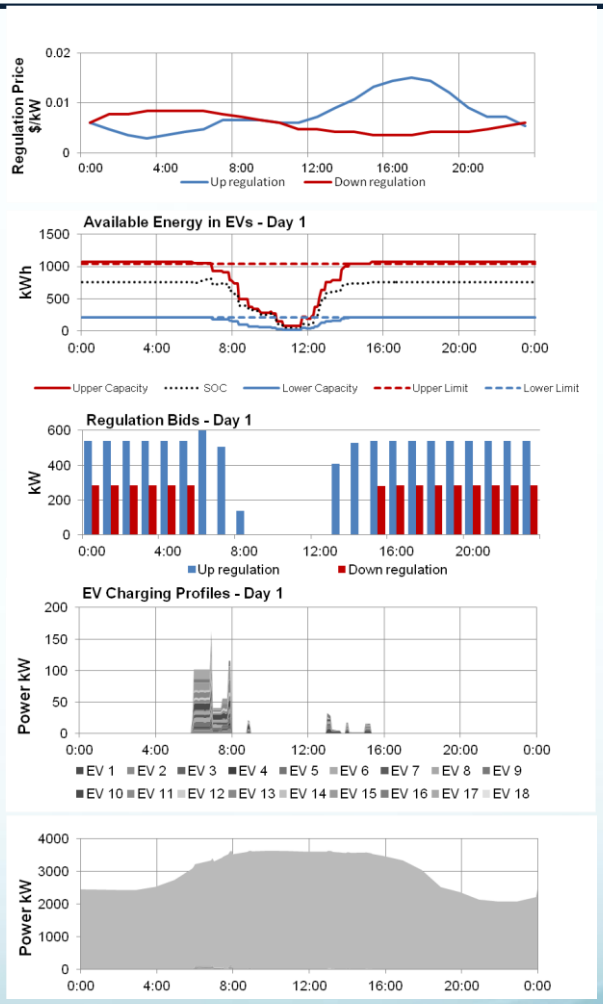
*Leading, Environmentally friendly, Affordable, Family car*

2. AC propulsion technology

3. J1772 combo connector

# EV Results Summary

| | | | |
|---|---|---|---|
| Energy Costs ($) | | | 22.65 |
| Power Costs ($) | | | 0 |
| Reg Revenue ($) | Up | D1 | 83.01 |
| | Dn | D1 | 24.53 |
| | Up | D2 | 85.37 |
| | Dn | D2 | 24.55 |
| Energy limit (kWh) | High | D1 | 1039 |
| | Low | D1 | 214.8 |
| | High | D2 | 1039 |
| | Low | D2 | 214.8 |



# Project Challenges

- regulatory barriers
  - need special tariff approval (hybrid wholesale-retail)
  - CAISO NGR rules under development
- equipment availability and cost
  - bidirectional vehicles and specialized charging stations
  - OCPP & CHAdeMO
- security
  - cyber security approval
  - physical security of vehicles

  +++++++++
- CAISO minimums
  - > additional vehicles
  - > charging-discharging control
- diversity of equipment
- CHAdeMO & OCPP support – TARDEC requirements
- cyber security
- general contracting issues, e.g. CEC title, 14th LEAF, etc.
- . . .. THIS IS AN R&D PROJECT

# Thank you!

http://microgrid.lbl.gov/